

Federal Aviation Administration AFS-205 404.474.5620	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 10 - 01	Revision 3
Title: Night Vision Goggle (NVG) Evaluation for Helicopter Flight Simulation Training Devices		Effective Date: May 5, 2014	Page 1 of 13

FSTD Guidance Bulletin 10 - 01

Night Vision Goggle (NVG) Evaluation for Helicopter Flight Simulation Training Devices

Purpose:

This document outlines the criteria for evaluating Night Vision Goggle (NVG) systems installed in FAA Qualified Helicopter Flight Simulator Training Devices

Scope:

This Guidance Bulletin provides an acceptable means, but not the only means of compliance with Title 14 Code of Federal Regulations (CFR) Part 60 pertaining to the Evaluation and Qualification of Flight Simulation Training Devices (FSTD) used in FAA Approved Flight Training Programs. If an applicant chooses to utilize the approach described within this Guidance Bulletin, that applicant must adhere to all methods, procedures, and standards herein. Should an applicant desire to use another means, a proposal must be submitted to the National Simulator Program Manager (NSPM) for review and approval prior to implementation. This Guidance Bulletin does not change regulatory requirements or create additional ones, and does not authorize changes in, or deviations from, regulatory requirements.

Approval: Harlan Gray Sparrow III
National Simulator Program Manager

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.474.5620	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 10 - 01	Revision 3
Title: Night Vision Goggle (NVG) Evaluation for Helicopter Flight Simulation Training Devices		Effective Date: May 5, 2014	Page 2 of 13

REVISION HISTORY		
Rev	Description of Change	Effective Date
0	Original	01/06/2010
1	Delete "Level A" FSTD in 3a. Add 3d. Clarify 3e, bullet 1 and 5(1) b, 5(3) c, & 5(5) a. Delete reference to pre-flight - 5(2) a. Added footnotes 1, 2 & 3.	04/30/2010
2	02/ 09/2012: Draft created during working group meeting in Dallas. 10/31/2012: Draft jointly created by FSI and CAE after system testing and validation. Distributed to Working Group for comment. 11/5/2012: Added Outlook comment on NVG Surface Resolution Test. 1/11/2013: Added NSP Comments and corrected typographical errors. 1/14/2013: Updates following meeting.	02/01/2013
3	Updated the reference location of FSB reports from www.opspecs.com to http://fsims.faa.gov/ . Provide additional clarification of objective testing procedures and provide attachment 1. Objective test requirement 4e altered to be contingent upon subjective evaluation.	05/05/2014

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.474.5620	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 10 - 01	Revision 3
Title: Night Vision Goggle (NVG) Evaluation for Helicopter Flight Simulation Training Devices		Effective Date: May 5, 2014	Page 3 of 13

1. APPLICABILITY.

This procedure applies to all helicopter Flight Simulator Training Devices (FSTD) used to satisfy the training and checking requirements pertaining to the certificate holder's approved NVG flight training program and the Flight Standardization Board Report for the aircraft. A copy of Flight Standardization Board Reports may be found on the FAA's public Flight Standards Information System (FSIMS) at <http://fsims.faa.gov/>. For the purpose of this document, "NVG" will be used as a generic term for Night Vision Goggles defined as a Direct View (Image viewed directly in-line with the image intensification process), head-mounted, binocular, light intensification appliance that enhances the ability to maintain visual surface reference at night.

The methods, procedures, and standards defined in this document provide one means, acceptable to the Administrator, to evaluate and qualify a simulator for NVG training. If an applicant desires to use another means, a proposal must be submitted to the National Simulator Program Manager. If an applicant chooses to utilize the approach described in this document, the applicant must adhere to all of the methods, procedures, and standards herein. Creditable hours of training will be determined by the TPAA having oversight authority.

2. STATEMENT OF COMPLIANCE.

Qualification Test Guides for new or upgraded simulators incorporating NVG training shall contain an NVG Statement of Compliance. This statement must attest that any associated NVG equipment, including Night Vision Imaging Systems (NVIS), effectively integrates all components required to successfully and safely use NVGs. This Statement of Compliance must be updated annually by a Helicopter NVG Current and Qualified Pilot.

3. SIMULATOR NVG STANDARDS.

This section describes the minimum requirements for qualifying a simulator for NVG training.

- a. The simulator used for NVG training must be an FAA qualified Level 6 or 7 FTD, Level B, C, or D FSTDs.

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.474.5620	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 10 - 01	Revision 3
Title: Night Vision Goggle (NVG) Evaluation for Helicopter Flight Simulation Training Devices		Effective Date: May 5, 2014	Page 4 of 13

- b. The simulator's cockpit configuration must simulate the functionality and intent of the Aircraft Type Certificate or a Supplemental Type Certificate (STC) required for the specific make, model, and type of aircraft being simulated.
- c. The Training Facility shall maintain an adequate number of certified NVG appliances to properly test the compatibility of the simulator for NVG training.
- d. The Training Facility shall maintain, in a binder, the following documents for inspection: Copy of the Statement of Compliance, Copy of the STC, a statement that the FSTD effectively simulates the Aircraft STC Conformity, Master Drawing List for supplemental lighting system, Rotorcraft Flight Manual Supplement for NVG Compatible Lighting System, Instructions for Continued Simulator Maintenance and NVG component replacement, detailed drawings of NVIS lighting installation, filtration installation, and all other applicable cockpit NVIS adaptations.
- e. The simulator environment must be suitable for NVG training:
 - If windshields are required by the base qualification of the FSTD, then the effects of the windshield on NVG visual and non-NVG visual should be similar as possible to the aircraft.¹
 - Displays or lighting outside of the cockpit area, if installed, do not interfere or distract from NVG training.
 - Operational steerable (visible light, non-IR) searchlight, as appropriate for the aircraft configuration, used for identification of wires, poles and other obstructions. Use of the searchlight shall realistically aid in detection of poles and wires.²
 - Suitable seat adjustment for proper NVG training.
 - Proper cockpit lighting, suitable for NVG training.
 - No distracting light leaks, glare or unrealistic halo effects.

¹ Any tint or color is likely to adversely affect the brightness performance of the out-the-window (OTW) visual.

² Wires and poles are virtually impossible to see while using NVGs.

Federal Aviation Administration AFS-205 404.474.5620	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 10 - 01	Revision 3
Title: Night Vision Goggle (NVG) Evaluation for Helicopter Flight Simulation Training Devices		Effective Date: May 5, 2014	Page 5 of 13

- External lighting does not interfere or distract from NVG training.
- f. The instructor must have the capability of selecting and viewing the visual scene (or a suitable representation) that is being presented to the pilot. The viewing requirement may be satisfied with the provision of a set of NVGs for use by the instructor, or by an alternate video representation at the IOS that includes the effects of the NVG image viewed by the pilot. An IOS compatible hand held (remote control) may be used in lieu of the IOS display by the instructor pilot if it does not distract from NVG training.
- g. An adequately modeled NVG training area in night visual meteorological conditions (VMC) must be available for evaluation by the NSP. Modeling must enable the following as applicable for the qualification level of the FSTD:
- Ability to conduct operations to and from a landing area.
 - Takeoff and landing areas suitable for ground maneuvering.
 - Confined area takeoffs and landings.
 - Pinnacle takeoff and landing.
 - Representative obstacles associated with the landing area, specifically wires, power lines, power poles or towers.
 - Special weather representations as required in the applicable training program(s).
 - Visibility restrictions for dust, rain, fog and snow.³
 - Increase in the halo effect when viewing light sources is proportionally increased with an increase in density of water vapor.
 - Increase in NVG noise as scene illumination level is decreased
 - Simulated external aircraft lighting (searchlight, landing lights) should appear as close to realistic as possible.
 - Simulated shadows of aircraft lighting should be available to cue pilots with regard to hover height and to assist in touchdown.

³ Ambient light levels decrease, and a loss of visual acuity occur with increased in dust, rain, fog or snow.

Federal Aviation Administration AFS-205 404.474.5620	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 10 - 01	Revision 3
Title: Night Vision Goggle (NVG) Evaluation for Helicopter Flight Simulation Training Devices		Effective Date: May 5, 2014	Page 6 of 13

- h. A morning readiness test shall be available to validate system operation prior to use for NVG training. It shall include, under NVG illumination conditions, and as a minimum:
- Overall scene alignment and inter-channel luminance consistency.
 - Visibility of image modulation
 - Support for focusing NVGs

4. OBJECTIVE TESTING.

While cockpit lighting, aft-cab, IOS and flight deck ambient light levels should typically be configured for NVG operations, it is recognized that resulting glare may impede objective measurement. Where light levels influence measurement or create distracting effects, it is permissible to lower lighting levels during objective testing portion of the evaluation. Measurements should be accomplished using a calibrated CS100/LS100 Minolta Color & Luminance meters or equivalent.

a. Visible Black Level

The display brightness for a low visibility night scene, when configured for NVG operations, should be no more than 0.01 candelas/square meter (cd/m^2) in an unlit portion of a displayed scene as measured from the pilot eye-point. This test is performed with a direct view of the visual display system image.

b. NVG Highlight Brightness

When configured for NVG operation the highlight brightness shall not be less than one (1) foot-lambert (3.4 cd/m^2). This test is performed with a direct view of the visual display system image. The pattern shall be a white square with a highlight imposed on the square corresponding to that used in the Part 60 visual display objective test 4.e, Highlight Brightness.

c. NVG Surface Contrast Ratio

The NVG surface contrast ratio shall be a minimum of 4.0:1. Measurements should be made using a raster drawn test pattern filling all channels of the entire visual scene with a test pattern of black and white squares with a white square in the center of each channel similar to that used in the Part 60 visual display objective test 4.d, Surface Contrast Ratio. Each square should subtend 5° . The white squares should provide

Federal Aviation Administration AFS-205 404.474.5620	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 10 - 01	Revision 3
Title: Night Vision Goggle (NVG) Evaluation for Helicopter Flight Simulation Training Devices		Effective Date: May 5, 2014	Page 7 of 13

a visible brightness of no greater than 0.04 foot-lamberts or 0.14 cd/m². Measures should be taken from the pilot's eyepoint. The ratio is calculated by dividing the NVG-weighted radiance of the center bright square by the NVG-weighted radiance of any adjacent dark square. Measurements can be accomplished using a 1° spot photometer through an NVG appliance representative of the type used in training. The appliance gain must be the same for both readings. A direct photometric measurement will not yield an equivalent value.

d. Lunar Illumination

The luminance of a full white Lambertian surface⁴ under 100% lunar illumination at 90 degree elevation (moon directly overhead) with clear atmospheric conditions shall be 0.10±0.025 candela per square meter. The luminance under other lunar elevations and phases shall realistically simulate real-world lunar illumination to the extent possible. The displayed visual model may be a real world or generic scene. The surface under test shall only be illuminated by the moon. No aircraft, cultural, or artificial lighting shall be applied. The area to be tested shall be identified as part of the test procedure, and would typically be expected to be a white paint stripe or other runway marking.

e. NVG Image Color

The NSP evaluator will first attempt to subjectively determine that there is no distracting color shift from white light in the unaided view. Scenes that exhibit an unrealistic color tint are not acceptable. If acceptability cannot be determined subjectively, the sponsor must verify acceptability of the NVG image color using the following objective test.

When configured for NVG operation, the CIE 1931 xy color co-ordinates of white objects in the scene (e.g. paint stripes) shall fall within a specified radius circle of radius relative to object chromaticity under daylight conditions. The radial xy deviation of white objects from daylight to NVG mode operation shall be less than 0.03 for lunar illumination levels between 100% and lunar illumination resulting in a luminance of 0.02 candela per square meter on a fully reflective lambertian surface. Higher levels of xy deviation are allowed on lunar illumination levels less than the above; however, the resulting color shift shall be non-distracting. This objective test does not preclude using different sun and moon

⁴ **Lambertian reflectance** is the property that defines an ideal [diffusely reflecting](#) surface. The apparent brightness of such a surface to an observer is the same regardless of the observer's angle of view.

Federal Aviation Administration AFS-205 404.474.5620	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 10 - 01	Revision 3
Title: Night Vision Goggle (NVG) Evaluation for Helicopter Flight Simulation Training Devices		Effective Date: May 5, 2014	Page 8 of 13

illumination colors; however, the daylight chromaticity reference measurement for the deviation calculation must use the moon illumination color. The method of establishing the reference shall be identified as part of the test procedure. No distracting color shifts shall be applied to light points, searchlights, and other highlights. For additional background, reference attachment 1 of this document.

The ability of instruments to measure color at low luminance levels may require that the measurement is made at the output of the projector rather than with a direct view of the visual display system image. The apparent color shift under this high brightness test condition may be quite apparent, even while respecting the allowed tolerance. Given that the color will be less saturated when seen by the pilot under NVG illumination conditions, this should not be a point of concern. Exercise extreme caution as injury to personnel or damage to equipment may result.

f. NVG Surface Resolution

Surface resolution shall be not greater than five (5) arc minutes when viewed through the NVG under 25%, 50%, and 100% moon lighting conditions. The displayed scene shall be similar to that used in the Part 60 visual display objective test 4.f, Surface Resolution. It is suggested that the initial aircraft distance from the runway threshold be greater than the minimum required such that the FSTD may be “flown” down the glideslope with corresponding cockpit indications and frozen in position when the individual white paint stripes are discernable. The distance from the runway threshold should be available at the IOS.

When the eye is positioned on a 3° glide slope at the slant range distances indicated with white runway markings on a black runway surface, the eye will subtend five (5) arc minutes:

- a. A slant range of 2750 ft. with stripes 150 ft. long and 16 ft. wide, spaced 4 ft. apart.
- b. For Configuration A, a slant range of 2063 feet with stripes 150 ft. long and 12 ft. wide, spaced 3 ft. apart.
- c. For Configuration B, a slant range of 3953 feet, with stripes 150 ft. long and 5.75 ft. wide, spaced 5.75 ft. apart.

An SOC is required and must include the appropriate calculations and an explanation of those calculations.

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.474.5620	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 10 - 01	Revision 3
Title: Night Vision Goggle (NVG) Evaluation for Helicopter Flight Simulation Training Devices		Effective Date: May 5, 2014	Page 9 of 13

g. NVG Light Point Contrast Ratio

The NVG light point contrast ratio shall not be less than 25:1. The ratio is calculated by dividing the NVG-weighted radiance a square of at least 1° filled with light points with light point modulation just discernible by the NVG-weighted radiance of the adjacent background. This test pattern is similar to that used in the Part 60 visual display objective test 4.h, Light Point Contrast Ratio. Measurements should be taken from the pilot's eyepoint. Measurements can be accomplished using a 1° spot photometer through an NVG appliance representative of the type used in training. The appliance gain of the NVG device must be the same for both readings. A direct photometric measurement will not yield an equivalent value.

5. FUNCTIONS AND SUBJECTIVE TESTING.

An FAA-NSP Simulator Evaluation Specialist or other qualified pilot designated by the NSP will evaluate the simulator for NVG compatibility. The evaluation will include the tasks listed below using the operator's approved manuals and checklists. Handling qualities, aircraft performance, and simulator systems operation will be evaluated while wearing NVGs.

Only those phases of flight and qualified tasks (in accordance with the qualification level of the device as defined in Table C1B or D1B of 14 CFR Part 60, as applicable) authorized for NVG use will be evaluated. Additional tasks not listed may be required to assure NVG performance is appropriate for use in pilot training as specified in the sponsor's approved training program. The evaluation will be conducted using night conditions. The visual scene shall simulate the actual night environment as viewed both aided and unaided at moon illumination levels between 0% and 100%.

NVG training may be conducted with the moon elevation angle fixed at 90 degrees. If training is to be conducted with angles other than 90 degrees, then shadows computed as a function of moon angle shall be displayed.

1) PREPARATION FOR FLIGHT:

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.474.5620	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 10 - 01	Revision 3
Title: Night Vision Goggle (NVG) Evaluation for Helicopter Flight Simulation Training Devices		Effective Date: May 5, 2014	Page 10 of 13

- a. Inspect and adjust NVG appliance in accordance with the operator's approved procedures.
 - b. Evaluate cockpit environment for suitability of head-mounted NVG. Determine ability to view cockpit instrumentation, switches, and controls below NVG field of view.
- 2) TAXI / TAKEOFF:
 - Evaluate the use of NVGs for focus, depth perception, brightness, contrast, and field of view while performing the following tasks:
 - a. Taxiing, on wheels and/or while hovering.
 - b. Normal takeoff from a hover.
 - c. Normal rolling takeoff.
 - d. Takeoff with abnormal occurrence: Engine failure, CAT A / B.
- 3) INFLIGHT:
 - a. Check for adequate ground reference while straight and level.
 - b. Check for adequate ground reference while maneuvering: Turns, climbs and descents.
 - c. Night scenes with a moon shall be evaluated for suitability with NVIS.
 - d. Navigate to a designated area via ground reference.
 - e. Check navigation by instruments.
 - f. Check system parameters. (Instruments, panel illumination, ability to read checklist, etc)
- 4) APPROACH/MISSED APPROACH/GO-AROUND:
 - a. Visual approach to a confined area without reference to ground lighting.
 - b. Engine out approach for multiengine aircraft.
 - c. Respond to a change from VMC to instrument meteorological conditions (IMC).
- 5) MALFUNCTIONS:
 - a. During hover, takeoff, cruise, approach and landing.
 - b. Malfunctions may be selected from the Operator's Approved Flight Manual Abnormal Procedures section.

Note: Emphasis should be placed on the simulator's capability to demonstrate compatibility for NVG training and the ability to display adequate visual scenes such that the pilot can identify the required visual references for night VFR flight.

Federal Aviation Administration AFS-205 404.474.5620	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 10 - 01	Revision 3
Title: Night Vision Goggle (NVG) Evaluation for Helicopter Flight Simulation Training Devices		Effective Date: May 5, 2014	Page 11 of 13

Attachment 1: The Nature of Chromaticity

The concept of color can be divided into two parts: a pair of chromaticity coordinates (x,y) and a luminance (Y). The xy value specifies a color, and the Y luminance value is related to perceived brightness. For example, the color white is a bright color with a particular xyY value, while the color grey is a less bright version of that same white with the same xy values but a smaller Y. As the level of illumination decreases, so does the eye's ability to discern color. A person's perception of color, then, is dependent both on the "true" color of the object (as would be measured by an instrument and represented by the CIE chart below), and by the brightness of the scene. Scenes with low brightness levels, such as those typical of NVG operations will be perceived to have less color saturation, and will eventually be perceived to be monochrome.

Current flight simulators often take advantage of this psychophysical phenomenon to achieve acceptable NVG training using real goggles looking out-the-window. Typical flight simulator displays do not have enough near-infrared energy to properly stimulate NVGs. Simulators equipped for NVG training often employ an "NVG-mode" compromise where the night scene is made slightly reddish to better stimulate the NVGs. If this is done properly, the NVG view is enhanced while the unaided under-the-goggle view appears virtually normal since color is hard to distinguish at low lunar illumination conditions. However, if too much red is added or if the scene is made too bright, the NVG view will indeed be further enhanced; but the unaided scene can take on a distracting reddish cast or the pilot's unaided view can be unrealistically good for the lunar illumination level being simulated.

This Guidance Bulletin places objective limits on the above artifacts by:

1. **Specifying Allowed Lunar Illumination Levels** – Objective test 4d tests that lunar illumination levels are within an acceptable range compared to equivalent real-world lunar illumination conditions. As a result, the out-the-window scene cannot be made too bright to artificially enhance the NVG view.
2. **Specifying Allowed Color Deviation** – Objective test 4e limits the allowed color deviation as a function of lunar illumination level. A

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.474.5620	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 10 - 01	Revision 3
Title: Night Vision Goggle (NVG) Evaluation for Helicopter Flight Simulation Training Devices		Effective Date: May 5, 2014	Page 12 of 13

moderate color deviation is allowed between 100% lunar illumination and light level approximately equivalent to 30% real-world lunar illumination. No color deviation limits are levied below the approximate 30% level since color perception is virtually non-existent at those levels.

Allowed color deviations are specified in terms of 0.03 radius circular regions on the 1931 CIE chromaticity diagram as illustrated in the figure below. The allowed deviation is referenced to a *Color Deviation Reference Point* as shown on the figure. We cannot reference the allowed deviation to “white” because simulators may use different non-white colors for daylight solar illumination and for lunar illumination. Rather, the reference point for the deviation calculation must be measured. As suggested in test 4e, this can be done by measuring a fully reflective scene object under high illumination levels where no color boost is being employed while assuring that same illumination color is being used. The specific method of establishing the reference, then, shall be identified as part of the test procedure.

UNCONTROLLED COPY WHEN DOWNLOADED

Verify correct revision at: http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

Federal Aviation Administration AFS-205 404.474.5620	<h1>National Simulator Program</h1> <h2>Flight Simulation Training Device Qualification Guidance</h2>	Guidance Bulletin Number: 10 - 01	Revision 3
Title: Night Vision Goggle (NVG) Evaluation for Helicopter Flight Simulation Training Devices	Effective Date: May 5, 2014	Page 13 of 13	

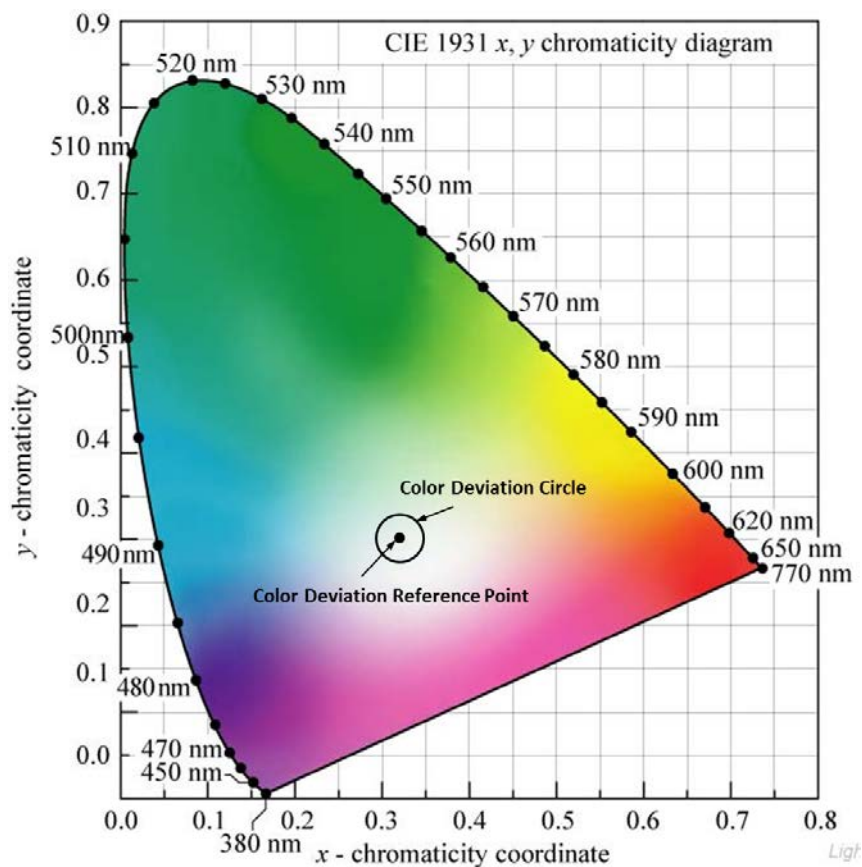


Figure 1. CIE1931 x, y Chromaticity Diagram showing a typical reference point and the allowable .03 xy deviation